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Abstract of

USMC FIELD ARTILLERY: DOCTRINE TO PROCUREMENT MISMATCH

The U. S. Marine Corps artillery forces, both active and reserve, now employ only one type of howitzer. The current procurement plan is to replace the M198, towed 155mm howitzer with another towed 155mm howitzer. Although an admittedly a better howitzer, it still does not provide Marines with the "full spectrum" force structure required by the guidance found in National Strategy and National Military Strategy.

This paper describes a method to evaluate the proposed howitzer against the current howitzer (as a baseline) and four other systems using a weighted model with 20 different criteria that are measures of effectiveness for artillery. The model weights are adjusted for three different scenarios (Marine Expeditionary Unit, Forced Entry, and Major Theater War), and the scores are provided in the appendices.

The primary conclusion is that one type of artillery system cannot satisfy the "full spectrum" of requirements. Recommendations are provided for a near term and future artillery force structure that includes a combination of cannon and rocket systems.

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USMC FIELD ARTILLERY; DOCTRINE TO PROCUREMENT MISMATCH

INTRODUCTION. Since the 1980's the U.S. Marine Corps has gone down the path toward an artillery force consisting of a single 155 towed weapon system for every battalion, active and reserve. Admittedly, there were external factors that drove us down that path, but we shouldn't allow them to institutionalize an undesirable condition. Even though the problem is recognized,¹ there doesn't seem to be much forward momentum to recover the broader range of artillery capabilities. We have more than one kind of mortar, machine gun, truck, helicopter, fixed-wing aircraft and radio in the Marines; the self-imposed "requirement" to field only one type of artillery system seems artificial. The underlying premise of this force planning paper is that U.S. Marine Corps artillery procurement is not completely consistent with the Marine Corps doctrine and tradition of being able to fight "in every clime and place." The paper is organized into three basic parts consisting of a short review of U.S. Marine Corps warfighting requirements, an analysis of various measures of artillery system effectiveness against six representative weapon systems, and finally some alternatives and recommendations. There are a multitude of ways to analyze this problem, so there is no claim here to be comprehensive. There is also an expectation that much of the analysis will be subject to opinion and interpretation. Articles in the *Marine Corps Gazette*, *Army Field Artillery Journal*, and defense trade journals have contributed to this discussion over the last couple of years, so none of this is claimed to be original thought. The goal is to bring many of those ideas about USMC artillery acquisitions under one tent and describe a systematic way to analyze the problem. In the end, one artillery system, no matter how good, will not prepare Marines for the variety of required artillery missions.

WARFIGHTING REQUIREMENTS. The National Command Authority has provided clear directions for, and expectations of the Marine Corps. The Navy and Marine Corps translate that strategy into operational concepts. Where we might fight is also important.

Marine missions fall into three broad categories and those provide a method to analyze how varying scenarios might affect artillery measures of effectiveness.

The President's *National Strategy for a New Century*, describes a requirement for the armed forces to "maintain an ability to respond across the full spectrum of potential crises, up to and including fighting and winning a Major Theater War (MTW)." The new (October 1997) *National Military Strategy* (NMS) reinforces the requirement for "full-spectrum" and "multi-mission forces." The previous (February 1995) NMS was very specific. "Forward deployed naval expeditionary forces can respond immediately to a crises, execute forcible entry or reinforce other forward deployed elements, and through prompt action help halt an enemy offensive and enable the flow of follow-on ground and land-based air contingents."² The current document backed off that level of service specificity but still requires our armed forces in general to be able to "halt an enemy" and be capable of "forcible entry." The words "forward deployed Naval Forces" have also been removed, but the generic concept of "overseas presence" is listed as one of our four military strategies. A further change reflected in the new NMS is the inclusion of the warfighting imperatives from the Chairman's *Joint Vision 2010* (JV2010). "Dominant maneuver, precision engagement, full dimensional protection, and focused logistics" are woven into the NMS. There remains a requirement for Marines to field flexible, full-spectrum combat forces.

How then does the Navy/Marine Corps team support those requirements? The 1992 Navy and Marine Corps document *From the Sea* stated that naval forces will "provide the littoral "enabling" capability for joint operations in conflict . . . as well as continued participation in any sustained effort." In 1994, *Forward from the Sea* continued to recognize expeditionary power projection as the naval priority but said "to proceed cautiously so as not to jeopardize our readiness for the full spectrum of missions and functions for which we are responsible." Although both those documents precede the national guidance, they support the requirement for flexible, full-spectrum presence and power projection.

Next, Marines must translate that strategy into a meaningful discussion about doctrine, tactics and resultant equipment alternatives. *Marine Corps Doctrinal Publication-1, Warfighting* (MCDP-1) states that "Marine Corps force planning is concept-based." We then look at what concepts are most relevant for force planning. *Operational Maneuver From the Sea* (OMFTS), published in January 1996, establishes an operational concept and it gives us an idea of where the future Marine Corps might fight:

"Littorals provide homes to over 3/4 of the world's population, locations for over 80% of the world's capital cities, and nearly all the marketplaces . . . littorals are also the place where most of the world's important conflicts are likely to occur. . . . Close associations with the littorals is one of the few things that conflicts of the near future are likely to have in common For that reason it is imperative that the Marine Corps resist the temptation to prepare for only one type of conflict" ³

The operational concept described in OMFTS is the "marriage of naval warfare and maneuver warfare."⁴ It uses the protection of the sea combined with high speed, high tempo operations to attack the enemy at the time and place of our choosing. A follow-on tactical concept paper, *Ship to Objective Maneuver* (STOM) discusses how the Marines might attack an objective directly and avoid establishing a beachhead by capitalizing on the mobility of the V-22 tilt rotor aircraft, the Advanced Amphibious Assault Vehicle (AAAV) and the Landing Craft Air Cushioned (LCAC).⁵ Although the OMFTS and STOM concepts are terrain independent, we need to keep in mind that equipment is terrain dependent. The next warfighting experiment, "Urban Warrior," and its complementary concept paper, *A Concept for Future Military Operations on Urbanized Terrain*, further recognize the urban nature of the littorals. As do all the concept papers partially addressed here, "Urban Warrior" describes the challenge to fire support agencies in that environment.⁶

Overlay those concepts with the current world situation and it indicates a need to be prepared for full-spectrum combat in desert, jungle, mountainous, or urban littorals without the luxury of a beachhead; a pretty broad charter. Since all combinations of terrain and scenarios are too broad to analyze here, I'll focus on three types of Marine operations. They are directly

or indirectly tasked by the NMS. The first is Marine Expeditionary Unit (MEU) "forward presence" mission. In recent years some examples are: amphibious assault in Grenada, peacekeeping in Beirut, humanitarian assistance in Bangladesh, rescuing Capt O'Grady in Bosnia, non-combatant evacuations from Liberia, and a combination of the above in Somalia. That means that the artillery battery assigned to a MEU needs to be transportable by air or surface, capable of providing 24 hour close fire support to the ground combat element, and suitable for a wide variety of missions. The MEU will generally depend on the air and naval surface fires to fight any deep fight or counterfire. The second mission is "forcible entry." It will normally be conducted with at least the forward elements of a Marine Expeditionary Force (Regimental sized landing). The initial landings may be STOM, but the requirement to defend a port or airfield for follow on forces will likely be required. For artillery forces, the longer range and higher lethality for defensive fires become more important. Like the MEU mission, Marines will probably get priority of air and naval surface fires for this mission. The third mission, the Major Theater War (MTW), may require a different force structure emphasis because Marines will probably not be the focus of effort for the Theater Commander. At this point we need the organic ability to shape our portion of the battlefield and provide counterfire. Range and lethality now become critical to offset the potential low priority of air and naval surface fires. These three categories are illustrative of how mission variance places a premium on a different characteristic of the artillery system. I'll return to these scenarios later in the analysis.

SYSTEM DESCRIPTIONS. What six artillery systems are compared? There are four howitzers and one rocket system compared. All of the systems are in production or development. All have elements of commonality with current systems, except the French Caesar, which was chosen because it's an interesting alternative. The last system is a mortar. Although mortars are generally considered to be an infantry weapon system, the Armored Mortar System (AMS) is included because it looks and acts more like a howitzer. It also

provides a look at a conceptual alternative to tracked self-propelled artillery. No current tracked artillery system is included for the very reason that Marines retired their tracked artillery after the Gulf War. They are more expensive to purchase, more expensive to operate, have a large logistics tail, and are heavy. A brief description of the six systems follows:

The AMS is a turret mounted 120mm smoothbore mortar, integrated onto a Marine Corps standard eight wheeled Light Armored Vehicle (LAV). It is capable of firing high and low angle and has a fully autonomous fire control system (similar to the US Army's Paladin). The system has been sold to the Saudi's with the first deliveries scheduled for 1999.⁷ One vehicle was tested at the Marine Corps Air/Ground Combat Center, 29 Palms California, during the last week of September 1997. It is capable of firing the current family of smoothbore ammunition common to the U.S. Army and can also fire the European "STRYX" precision anti-tank round.⁸

The British M119 towed light howitzer first became famous in the grueling conditions of the Falklands War. It was later fielded as the direct support howitzer for the U.S. Army light and airborne divisions in the mid 1980's. It fires the complete family of U.S. 105mm ammunition as well as some varieties of international ammunition. Its prime mover is the High Mobility Multipurpose Wheeled Vehicle (HMMWV).⁹

The M198 towed medium howitzer is currently used by all Marine Corps artillery units and is the general support howitzer for army light units. It was fielded in the early 1980's and saw extensive service in the Gulf War. Several other countries have also purchased it. It fires the entire family of U.S. 155mm munitions. Its prime mover is the M923 Five-Ton Truck.¹⁰

The Lightweight 155 (LW155), or XM777, is a joint towed howitzer replacement for the M198. The USMC and British Army are committed to purchase this howitzer and the program is currently in the engineering, manufacturing, and developmental (EMD) phase until the year 2000. The Army supports the program for fielding with its light divisions.¹¹ The primary improvements over the M198 are the weight reduction from 15,800 to 9,000 pounds

time and increased position area possibilities. There is a preplanned product improvement to provide on board fire control capability.¹²

The High Mobility Artillery Rocket System (**HIMARS**) is a developmental system that mounts one 6-rocket Multiple Launch Rocket System (MLRS) pod on the back of a five-ton truck. Other than having 6 rockets instead of 12, its operational capability will be identical to the MLRS. The advantage over the MLRS is the weight and therefore deployability. The secondary advantage is the maintainability of a wheeled platform. The Army is getting four systems for testing this year and wants to field the system in 2004 to their 16 Brigades that support light divisions. It reportedly made the cut for the Army 00 POM.¹³ There is a U.S. Marine Corps Mission Needs Statement for a "General Support Artillery System"¹⁴ and HIMARS would be a good candidate (if the Army buys it). To date no USMC money has been identified.

The French "Caesar" is a 155mm howitzer mounted on the back of a five ton truck. It has most of the mobility advantages of a tracked self propelled howitzer but is cheaper and lighter. Unlike tracked self propelled howitzers, it is C-130 transportable. Another attractive feature of the howitzer is that it has a 52 caliber cannon. This tube provides a significant range advantage with only about an extra 1,000 lbs. of weight. (The U.S. Army howitzer of the future, "Crusader," will also be 52 caliber.) Fifty two caliber cannons are able to fire the current family of ammunition but do not achieve maximum ranges with it. Caesar was included because it provides an interesting design comparison. The main problem is its weight (40,000 pounds).¹⁵

MEASURES OF EFFECTIVENESS AND COMPARISONS. Twenty measures of effectiveness were selected and grouped into five categories. Under each category and measure, each weapon system will be assigned a grade using a "stoplight chart" for comparison. The weights used in *Expert Choice* (decision support software) will reflect actual measures or my judgements about how much difference there is between the color codes for

each category. The figures from which the grades were assigned, where applicable, are attached as appendix A. For this step in the analysis scenarios will be put aside. I do however, encourage the reader to consider how various scenarios might affect relative importance as you go through the description of the effectiveness measures.

Transportability

In a discussion about equipment in MCDP-1: "A primary consideration is strategic and tactical lift - - the Marine Corps' reliance on shipping for strategic mobility and on landing craft, helicopters, and vertical/short takeoff and landing aircraft for tactical mobility"¹⁶

Weight	M119	120	AMSLW155	M198	155 wheeled	HIMARS
helo liftable?	G	Y	G	Y	Y	Y
prime mover?	G	N/A	Y	Y	N/A	N/A

Since all these systems will physically fit into a C-130, the **weight** comparison is measured in the context of tactical ship to shore movement and battlefield air mobility. Marines, like the British in the Falklands, may find ourselves in a situation where "helicopter transport dictates tactics."¹⁷ Systems which cannot be lifted by a CH-53E received a "Red," those which can be lifted by a CH-53E a "Yellow," and those able to be lifted by a V-22 a "Green."

Size	M119	120	AMSLW155	M198	155 wheeled	HIMARS
footprint, wpn only	G	G	G	Y	Y	G
wpn & prime mover	G	G	Y	Y	Y	G

Size was analyzed on the basis of square footage because that is the primary limiting factor for shipping (strategic mobility) and landing craft (tactical mobility). Given the perennial shortage of space on amphibious shipping and the pressure to build up combat power ashore as quickly as possible, size is especially important in any amphibious operation. Anything over 300 square feet (either the weapon itself or the combination of the weapon and prime mover) got a "Red," anything between 200 and 300 got a "Yellow," and less than 200 square feet got

a "Green." It may look like there is some double counting, but it will be adjusted with offsetting weights during the final computations

Crew Issues

Crew issues	M119	120 AMS	LW155	M198	155 wheeled	HIMARS
crew size	Y	G	Y	R	Y	G
crew protection	R	G	R	R	Y	G

In this analysis, **crew size** is important to a system because of the effect on structure. Smaller crews mean potentially more systems (such as a change from an 18 weapon to a 24 weapon battalion) or an increase to another part of the Marine Corps. It's tough to disassociate cost from the crew size discussion since the cost to the Marine Corps for personnel is 62% of our budget.¹⁸ Should a decision be made to not redirect personnel savings to other parts of the structure, a direct savings could be realized from a smaller crew. A smaller crew also affects transportation space on shipping or aircraft. Systems with crews larger than eight merited a "Red," those with crews from five to seven a "Yellow," and those with four or less a "Green." The second element, **Crew protection**, means fewer replacements are required, reduced medical support and better overall system survivability. In the Falklands campaign, "camouflage and entrenchments were practically impossible in the East Falkland peat . . . exposed British guns and crews provided the Argentine artillery with a perfect opportunity to blunt the British attack with an effective counter-battery effort."¹⁹ Systems with no protection received a "Red," those with protection while moving a "Yellow," and those with protection during firing a "Green."

Agility

Agility is the category of things that measure the ability of the system to be available and ready to fire, distinguished from the time spent moving or shifting positions. Some describe this as being able to keep up with maneuver.

	M119	120 AMS	LW155	M198	155 wheeled	HIMARS
mobility	G	G	Y	F	G	G

Ground mobility is a description of how well the weapon traverses various types of roads and terrain. It also includes the size of the firing position required to set up the weapon. All Marine artilleryman have been frustrated at one time or another by the inability to keep up with a maneuver element, especially during screening or delay and defend operations.

	M119	120 AMS	LW155	M198	155 wheeled	HIMARS
emplacement	Y	G	Y	F	G	Y

The second element of agility is **emplacement time**. In the Afghanistan theater "the Soviets found to their dismay that often ambushes ended and the enemy withdrew before accompanying guns could be brought into action."²⁰ Since Marines don't have Field Artillery Brigades to cover for Direct Support (DS) Artillery on the move, they regularly find themselves with 1/3 to 2/3 of the artillery out of firing position. Howitzers that are harder to emplace decrease the number of available tubes and tire crews quickly. Systems taking more than three minutes to emplace warranted a "Red," those between one and three a "Yellow," and those able to emplace in one minute or less a "Green."

	M119	120 AMS	LW155	M198	155 wheeled	HIMARS
fire without spades	F	G	F	F	F	G

Closely related to emplacement time and mobility is the **ability to fire without emplacing some form of spades**. The advantage of this capability is easy to imagine in urban terrain where "it is often hard to find a traditional battery or platoon position"²¹ or extreme cold where the U.S. Army tests conducted in 1946-47 showed it took 63 minutes to emplace a 105mm howitzer at 63 degrees below zero.²² The scores for this are either "Red" or "Green."

	M119	120 AMS	LW155	M198	155 wheeled	HIMARS
6400 mil capable	Y	G	Y	Y	Y	G

The ability to easily shift the azimuth of fire in a complete circle (6400 mils) is a measure of the artillery system's ability to quickly respond to targets from any direction. It also facilitates massing of fires. This capability is highlighted in peacekeeping experiences such as Beirut or the British Middle East Conflict,²³ when artillery was forced to sit in a firebase type environment and had to be able to respond in any direction. Systems which must shift trails for out of traverse missions recieved a "Yellow," and those which can quickly traverse using a turret or turret like system a "Green."

	M119	120 AMS	LW155	M198	155 wheeled	HIMARS
displacement	Y	G	Y	-	G	G

The last component of agility is **displacement time**. Like emplacement, this affects time spent out of action and crew fatigue, but it becomes more important as a survivability consideration in any scenario with a counterfire threat. "In the Yom Kippur War, Israeli guns had to be moved four or five times per day to avoid Arab artillery."²⁴ Systems that take more than two minutes to displace received a "Red," those taking between one and two a "Yellow," and those that could go from a firing position to moving in less than one minute a "Green."

Ordinance Delivery

Ordinance delivery is the combination of factors that we traditionally associate with the ability to put "steel on target." "We will use fires to exploit maneuver just as we use maneuver to exploit the effects of fires."²⁵

	M119	120 AMS	LW155	M198	155 wheeled	HIMARS
range	Y	R	Y	Y	G	G

The first quality is **range**. "Firepower must never become such a burden that it keeps the maneuver on a leash as short as the range of its own supporting artillery."²⁶ It is a tough quality to boil down to a choice of three colors because there is always the argument of whether the range includes Rocket Assisted Projectiles (RAP), what percentage of the basic load of ammunition is represented by long range capable powders, and what's in development. These scores represent range for standard powder, non-RAP ammunition. Those systems with less than 10 kilometers merited a "Red," those between 10 and 30 a "Yellow," and those over 30 a "Green."

	M119	120 AMS	LW155	M198	155 wheeled	HIMARS
lethality	R	R	Y	Y	Y	G

Lethality is a measure of whether the enemy is simply kept occupied or if he is destroyed. It is also tied to the reduction of ammunition trains. "Bomblet shells . . . although tremendously more expensive than regular iron munitions, may be worth the price if they can provide the requisite level of destructiveness while cutting down the bulk weight of ammunition . . ."²⁷ Since Improved Conventional Munitions (ICM) are the most lethal munitions, the number of bomblets that each of the various systems could carry was used. This is a good case where there is a vast difference between the systems, both in number of submunitions and their size, and the model is weighted to reflect that difference.

	M119	120 AMS	LW155	M198	155 wheeled	HIMARS
rate of fire	Y	G	Y	R	G	G

Rate of fire is related to lethality, but not directly, because subsequent rounds are not as lethal due to loss of surprise. Systems with a maximum rate of fire of up to four rounds per minute are "Red," five to seven are "Yellow," and eight or better are "Green." In the case of HIMARS, the limiting factor was the capacity of the rocket pod.

	M119	120 AMS	LW155	M198	155 wheeled	HIMARS
burst fire capable?	R	G	Y	R	G	G

A relatively new measure of firepower is the ability of one system to achieve **simultaneous impacts of multiple projectiles** by varying the time of flight (using different elevations and powder increments). It requires a high rate of fire, sophisticated on board fire direction equipment and variable propellant increments. This allows a single weapon to replicate the effects of massing several weapons and the advantage in fast moving situations where batteries or battalions are operating independently is revolutionary. Scores are either "Red" or "Green."

	M119	120 AMS	LW155	M198	155 wheeled	HIMARS
direct fire capable?	G	G	G	G		

Another firepower measure, **Direct Fire** capability, has traditionally been viewed by artillerymen primarily in the context of self-defense. With the increasing emphasis on urban combat, it is perhaps more important for the ability to engage the urban enemy without destroying entire buildings or blocks. In the battle for Berlin, although not particularly discriminative in its use, Russian artillery fire was 80% direct fire.²⁸ The scores for direct fire are either "Red" or "Green."

	M119	120 AMS	LW155	M198	155 wheeled	HIMARS
Precision capable?	R	G	G	G	G	Y

The last element in this section is the ability to use **precision** munitions. Use of precision munitions supports JV2010 and OMFTS because it more reduces collateral damage and like lethal munitions such as ICM, has the potential to reduce the huge ammunition tail associated with artillery. "In past campaigns, artillery ammunition and bombs have made up as much as 85% of the total tonnage of supply."²⁹ The area where artillerymen get their best advantage from precision munitions is engaging moving armor. "Red" means no moving armor capable munition is available, "Yellow" means one is in development, and "Green" means the capability is available now.

Sustainability

	M119	120 AMS	LW155	M198	155 wheeled	HIMARS
ammo interoperability	G	G	G	G	G	G
equip commonality	G	Y	G	G		G
maintainability	G	Y	G	G	Y	Y

The last group of measures of effectiveness is sustainability. **Ammunition commonality** is by far the most important because of the sheer mass of the joint procurement, storage and transportation effort. Although secondary to this analysis, it is also a large portion of an artillery system life cycle cost because of the annual training ammunition allocation. The score in this category is based on whether the system can use the same munitions as U.S. Army artillery systems. **Equipment commonality** is a measure of whether the system is common to other U.S. systems, or has component commonality. Common systems save on number of parts in the maintenance system and have spillover into all of the support systems such as training, publications, procurement and configuration management. A completely unique system to the Marine Corps is "Red," a system with component commonality between services

(or within the service) is "Yellow," and a fully common system between the Army and Marines is "Green." **Maintainability** is an attempt to measure the complexity of the system. It includes the number and types of mechanics required, number of parts required to be carried in the logistics tail, and time spent on maintenance, both preventive and corrective. Maintainable systems further reduce the logistics tail and support the concepts of OMFTS and JV2010.

THE MODEL. The next step in the process was to load the system scores into the model. Here is where the scenarios get folded back into the analysis. Although the scores for the systems stay the same, the relative weights between the measures of effectiveness and the categories change with each scenario computed by "expert choice." I ran three general scenarios: MEU, Forcible Entry, and MTW. The model can be run using terrain type, threat level or any other way one wants to weight the categories to "select" the best system. Sensitivity analysis indicated that drastic changes to the weights would need to be made to change the outcome. The printouts of the three scenarios are included as Appendix B, C and D. The scores strongly support a closer look at both the AMS and HIMARS, which were the first two choices in each scenario.

ALTERNATIVES. Before I present my recommendations, a discussion of some of the more popular alternatives is in order. As stated in the introduction, this subject is hotly contested and the focus has generally revolved around the ability of the current howitzer to keep up with maneuver elements, both in the ship to shore transition and in ground mobility once ashore. There seems to be three general schools of thought on how to be more responsive to maneuver. The first is to lighten up by transitioning to either a 120 mortar system, a 5" capable howitzer,³⁰ (neither considered in this study) or a 105mm towed howitzer. Any of those solutions improves agility but the 120mm or 105mm options raise serious concerns about ordinance delivery. The second school advocates the AMS.³¹ The primary objections are lack of range and lethality. The third school advocates the LW155 as

the answer because it can be picked up by a V-22 and has the advantage of 155mm ordinance.³² Detractors argue it's just a smaller M198.³³ The second concern, lack of range for the counterfire fight and other General Support (GS) missions, has generated a Mission Needs Statement. For the GS mission, there are only 2 schools of thought. One is to continue the current practice of planning to be supported by U.S. Army MLRS units. The obvious advantage is that the force structure is essentially "free" to the Marine Corps.³⁴ The skeptics say we shouldn't bet on getting that support for two reasons: First, the system is tracked and outsized, and therefore is not very deployable. Second, there is no dedicated Army MLRS unit for the Marines.³⁵ What Marine feels comfortable betting that MLRS will be available or deployable in a near simultaneous MTW environment? That brings us to the current status quo. For the near term, Marines intend to buy a single 155mm howitzer for all scenarios, and continue to depend on the Army for GS support.

RECOMMENDATIONS. For the near term, I recommend buying enough LW155s for 8 active and 3 reserve battalions (plus training, depot and preposition quantities). This is a reduction from the current plan of 10 and 5 respectively. The LW155 appears to be a good utility howitzer, especially if the Preplanned Product Improvement Program is funded. It has mobility improvements over the M198 in both vertical ship to shore movements and in ground mobility once ashore. On the negative side, it does not answer the need for a highly mobile artillery piece for fast moving mechanized units and it is still ultimately anchored by the five-ton truck.

I recommend buying 2 battalions of the AMS as soon as possible. The pre-production version was tested in 29 Palms during Sep 1997.³⁶ Marines have another near term opportunity to test the system during "Urban Warrior" in late 1998. Since the delivery to Saudi Arabia is planned for 1999, there is a small window of opportunity to keep that production line open. I further recommend that those are fielded as 24 tube battalions. The difference in crew size between the LW155 and the AMS should make that possible, even with

some increase in mechanics. The system provides a capability for artillery support in fast moving mechanized, urban, and other highly restrictive terrain operations. It further provides a test bed for a weapon of the future. The turret is going to be a USMC unique item, but the vehicle is already a proven and expanding member of the USMC inventory. The system as fielded to Saudi Arabia uses Mecar (Belgian produced) ammunition, but US ammunition should surpass those capabilities shortly.³⁷ There would also be a significant incentive for the mortar platoons of the LAV equipped battalions to convert from the 81mm to the AMS. Total system buy in the Marine Corps could approach 100.

To fill the already established need for the GS system, I agree with the recommendation to redesignate two of the five Selected Marine Corps Reserve (SMCR) artillery battalions from DS to GS and field them with HIMARS.³⁸ The Army plans to field 16 battalions starting in 2004, so Marine requirements could be added to their production. Since these weapons are primarily needed in a MTW scenario, assigning them to the SMCR is acceptable. "Active forces must be capable of responding immediately to most types of crises and conflict. Many sustained missions will require augmentation from the Reserve establishment."³⁹ How that translates to me is: active forces are needed for the MEU forcible entry missions, but Reserves can help during the MTW mission. Having just completed a tour as the active duty Inspector-Instructor for one of those battalions, I like the idea of "rockets for Reserves." SMCR Marines are capable of rapidly mobilizing and performing independent Battery or GS Battalion operations. They routinely operate with active duty artillery. Since the mission of the SMCR's Artillery Regimental HQ during MTW is to operate as a force fire support agency, with responsibility for rocket employment, it reinforces the assignment of HIMARS to the Reserves.

What about the Marine Corps artillery after next? From Saipan to Vietnam, Marines maintained an amphibious artillery capability.⁴⁰ As Donald Loughlin continues to ask in the *Gazette*, "why don't we have that capability now?"⁴¹ I don't believe it makes economic sense to backfit a capability onto the LVTP-7 series, but I agree with the need to develop a capability

for the AAV. The AMS turret is smaller and lighter than the proposed 35mm turret on the AAV⁴², so it can be used as a starting point in the discussion. If future growth of the 120mm mortar doesn't look promising, design something else. All three methods of moving amphibious forces ashore in OMFTS and STOM need organic fire support. The LW155 can fly or go by LCAC, but a system is needed to accompany the AAV force during ship to shore movement and subsequent operations ashore. I propose that two battalions of AAV artillery eventually replace the AMS battalions.

As for the future of the LW155, Marines have to get more range competitive with potential adversaries.⁴³ I recommend we convert to 52 caliber when the army makes Crusader its primary DS weapon system. Re-tubing the LW155 may require that the V-22 move it in two pieces, and that seems preferable to indefinitely accepting current range limitations.

"The future of rockets is in the ammunition, not the firing platform."⁴⁴ The next generation of rockets has a 45KM range, and the "BAT" brilliant munitions will soon be fielded.⁴⁵ If the Army stays on track with purchasing HIMARS for their Rapid Force Deployment Initiative (RFDI),⁴⁶ it will quickly take the mystery out of which system we should buy. With regard to structure, as long as 10 battalions of active duty artillery have to support 8 infantry regiments, there is no room for rockets in the active artillery. They must go into the Reserves.

SUMMARY. My recommendations are based on the top down warfighting requirements, starting with the National Strategy and NMS. that we need to be prepared to fight as MEUs, as a forcible entry force (or halt force) for a theater CINC, or supporting a MTW. The Naval Strategy of *Forward From the Sea* supports those, and demands Marines be prepared for a wide variety of littoral scenarios with flexible, full-spectrum forces. The JV2010 imperatives of precision munitions, dominant maneuver and focused logistics are all compatible with OMFTS and STOM. The ship to shore triad of AAV, LCAC and V-22 provide the tactical mobility to match the doctrine. The weighted scenario model supports the

conclusion that Marines need more than the LW155 to support the combat requirements, and resulting concept driven force structure. If a maneuver commander goes ashore or executes a subsequent operation without artillery support, it should be a conscious choice, not because Marines don't have an artillery piece that fits the mission.

NOTES

¹Maj Kevin M. McConnell, "1996 MAGTF Fire Support Conference," Field Artillery Journal, Sep-Oct 1996, 29.

²Department of Defense, National Military Strategy, (Washington D.C., Feb 1995), 14.

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⁴Ibid.

⁵U.S. Marine Corps, Ship to Objective Maneuver, Quantico, VA, Jul 1997, 3.

⁶U.S. Marine Corps, A Concept for Future Operations on Urbanized Terrain, Quantico, VA, Sep 1997, 4.

⁷Jane's Armor and Artillery, Seventeenth Edition, 1996-97, 632-633.

⁸Ron VanSickle, Delco Systems Operations (turret manufacturer), Coleta CA, telephone conversation with author, Sep 8, 1997.

⁹Jane's Armor and Artillery, Seventeenth Edition, 1996-97, 708-711.

¹⁰Jane's Armor and Artillery, Seventeenth Edition, 1996-97, 713-714.

¹¹Col Lynn Stuart, <Stuartl@silltcmd-smtp.army.mil> "HIMARS Reply," personal e-mail (Sep 6, 1997).

¹²Maj Kevin Rogers and John Yager, "M777 Firepower for the Future," Marine Corps Gazette, Oct 1997, 39-40.

¹³LTC Mark Wiley, US Army TRADOC Rocket System Manager, telephone conversation with author, Sep 15, 1997.

¹⁴Col Stuart, e-mail of Sep 6, 1997.

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¹⁶U.S. Marine Corps, Marine Corps Doctrinal Warfighting Publication-1. Warfighting, Washington D.C., Jun 20, 1997, 65.

- ¹⁷Robert H. Scales Jr., Firepower in Limited War, (NDU Press, 1990), 218.
- ¹⁸U.S. Marine Corps, Concepts and Issues-1997, (Programs and Resources Department, Washington, D.C.), figure 5-8, page 135.
- ¹⁹Scales, 215.
- ²⁰Scales, 162.
- ²¹J.B.A Baily, Field Artillery and Firepower, (The Oxford Military Press, Oxford, 1987), 77.
- ²²Baily, 86-87.
- ²³Baily, 261-2.
- ²⁴Baily, 96.
- ²⁵OMFTS, 6.
- ²⁶Scales, 246.
- ²⁷Scales, 243.
- ²⁸Baily, 73.
- ²⁹Scales, 243.
- ³⁰LtCol Forest R. Lindsey, "Marine Corps Direct Support Artillery and the MAGTF Mission," Marine Corps Gazette, Oct 95, 35.
- ³¹Capt Joseph L'Etoile, "A Replacement for Towed Artillery," Marine Corps Gazette, Oct 1995, 37-38.
- ³²Capt Matthew Bragg, "Assessing the M198," Marine Corps Gazette, Oct 95, 39; Capt Mark S. Gentil, "The King has No Clothes," Marine Corps Gazette, Sep 1994, 64.
- ³³Capt Robert E. Ogle, "What's Gained," Marine Corps Gazette, Oct 97, 40.
- ³⁴MajGen Leslie M. Palm, USMC, "Joint Fire Support - Training for the Future," Interview by Patrecia Slayden Hollis for Field Artillery Journal, Feb 95, 6-8.
- ³⁵Capt William R. Hittenger, "High Mobility Artillery rocket System: GS Artillery for the Corps," Marine Corps Gazette, Mar 97, 35-36.
- ³⁶John Doak, Delco Systems Detroit. AMS Project Manager, telephone conversation with

author on Oct 3, 1997.

³⁷Doak, Oct 3, 1997; Eric H. Blass, "When the Mortar Kicks Smartly, Further, Faster, Harder," Armada International, v20 no 3, Jun-Jul 1996, 56-57.

³⁸Hittinger, 36.

³⁹MCDP-1, 54.

⁴⁰LtGen Victor H Krulak, USMC (ret), First to Fight, (Naval Institute Press, Annapolis MD, 1984), 109.

⁴¹Donald J. Loughlin, "Amphibious Fire Support," Marine Corps Gazette, Oct 97, 43.

⁴²VanSickle telephone conversation on Sep 8, 1997.

⁴³Capt Carl Felton, "Marine Artillery: When Our Best Is Not Good Enough," Marine Corps Gazette, Sep 94, 61-62.

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⁴⁵MG Randall L. Rigby, Chief of Field Artillery. "Mapping the Future: Field Artillery Status of the Branch 1996," Field Artillery Journal, Nov-Dec 96, 1-2.

⁴⁶MG Randall L. Rigby. "Report Out: Service Fire Support Conference - Focusing on Fires for Force XXI," Field Artillery Journal, May-Jun 96, 19.

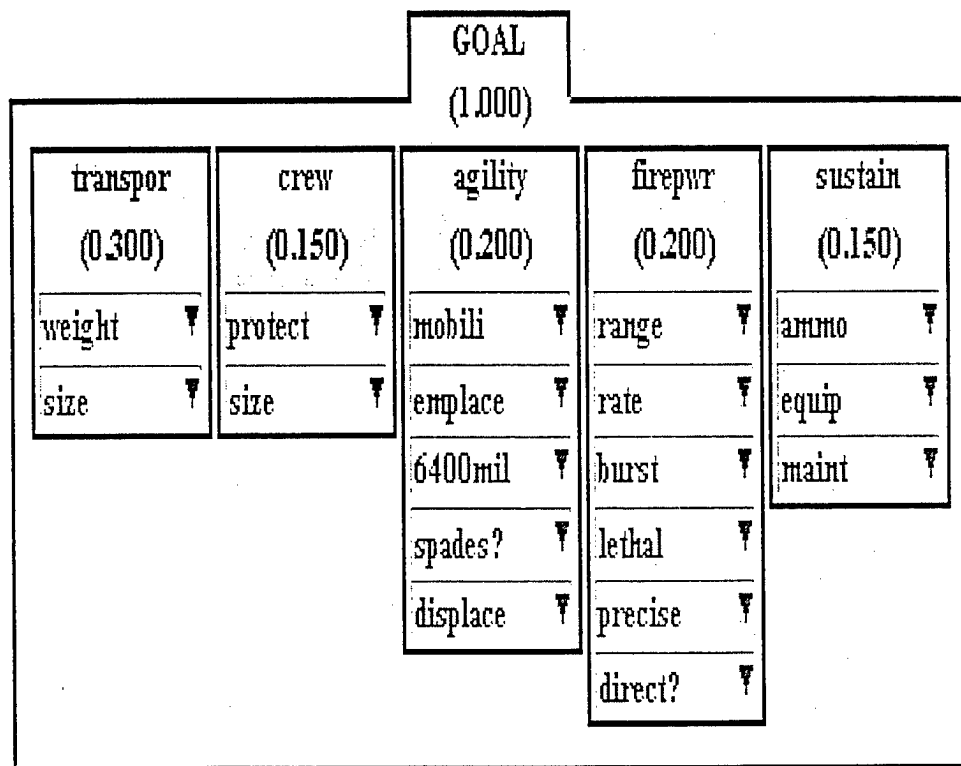
Measures of Effectiveness

Transportability	M119	120 AMS	LW155	M198	155 wheeled	HIMARS
weight-lbs	4100	30300	9000	15800	40800	30200
helo liftable?	G	Y	G	Y	Y	Y
weight of prime mover	5900	N/A	20900	20900	N/A	N/A
prime mover?	G	N/A	Y	Y	N/A	N/A
size-actual-ft	16x5.8	21.1x8.3	18.5x9.1	24.4x9.2	32.8x8.2	22.8x7.9
footprint-sq feet	93	177	168	224	269	180
footprint, wpn only	G	G	G	Y	Y	G
size of prime mover	12.7x7.2	N/A	25.9x8.1	25.9x8.1	N/A	N/A
prime mover-sq feet	91	N/A	210	210	N/A	N/A
wpn & prime mover	G	G	Y	Y	Y	G
Crew	M119	120 AMS	LW155	M198	155 wheeled	HIMARS
crew size	5	4	7	11	6	3
crew size	Y	G	Y	Y	Y	G
crew protection	Y	G	Y	Y	Y	G
model score for prot.	0	2	0	0	1	2
Agility						
mobility	G	G	Y	Y	G	G
model score for mob.	3	3	2	1	3	3
emplace time-min	2	1	2.5	3.5	1	2.5
emplacement	Y	G	Y	Y	G	Y
fire without spades	Y	G	Y	Y	Y	G
score for no spades	0	1	0	0	0	1
6400 mil capable	Y	G	Y	Y	Y	G
model score for 6400	1	2	1	1	1	2
displacement-time	2	1	2	3	1	1
displacement	Y	G	Y	Y	G	G
Firepower	M119	120 AMS	LW155	M198	155 wheeled	HIMARS
range-km std/RAP	11.5/19.5	9.0/+	14.6/30	14.6/30	32/42*	30/45**
range	Y	Y	Y	Y	G	G
lethality-submunitions	18	27	88	88	68	644/518**
lethality	Y	Y	Y	Y	Y	G
rate of fire max/sust	6/3	8/4	5/2	4/2	12/6	6
rate of fire	Y	G	Y	Y	G	G
burst fire capable?	Y	G	Y	Y	G	G
model score for burst	0	2	1	0	2	2
direct fire capable?	G	G	G	G	Y	Y
model score for direct	1	1	1	1	0	0
Precision capable?	Y	G	G	G	G	Y
score for precision	0	2	2	2	2	1

Measures of Effectiveness

Sustainability	M119	120 AMS	LW155	M198	155 wheeled	HIMARS
ammo interoperability	G	G	G	G	G	G
ammo score	3	3	3	3	3	3
equip commonality	G	Y	G	G	R	G
commonality score	3	2	3	3	1	3
maintainability	G	Y	G	G	Y	Y
maintainability score	3	2	3	3	2	2
+in development						
*extended range base bleed						
**replaces current series rocket						

MEU



MI19	AMS	LWI55	MI98	Whd155	HIMARS
------	-----	-------	------	--------	--------

Abbreviation	Definition

(Priorities shown are "local" - relative to parent node.)

Synthesis of Leaf Nodes with respect to GOAL

Ideal Mode

OVERALL INCONSISTENCY INDEX = 0.0

AMS	.207	
HIMARS	.200	
M119	.176	
Whd155	.159	
LW155	.141	
M198	.116	

Abbreviation	Definition
AMS	
HIMARS	
M119	
Whd155	
LW155	
M198	

MEU

Synthesis of Leaf Nodes with respect to GOAL

Ideal Mode

OVERALL INCONSISTENCY INDEX = 0.0

LEVEL 1	LEVEL 2	LEVEL 3	LEVEL 4	LEVEL 5
transpor=.300				
	weight =.150			
		wpnonly =.105		
			M119 =.105	
			LW155 =.048	
			M198 =.027	
			HIMARS =.014	
			AMS =.014	
			Whd155 =.011	
		w/truck =.045		
			M119 =.045	
			LW155 =.014	
			HIMARS =.013	
			AMS =.013	
			M198 =.011	
			Whd155 =.010	
	size =.150			
		w/truck =.120		
			AMS =.120	
			HIMARS =.118	
			M119 =.115	
			Whd155 =.079	
			LW155 =.056	
			M198 =.049	
		wpn only=.030		
			M119 =.030	
			LW155 =.017	
			AMS =.016	
			HIMARS =.016	
			M198 =.012	
			Whd155 =.010	
agility =.200				
	emplace =.060			

MEU

	AMS	=.060
	Whd155	=.060
	M119	=.030
	LW155	=.024
	HIMARS	=.024
	M198	=.017
mobili	=.040	
	M119	=.040
	AMS	=.040
	Whd155	=.040
	HIMARS	=.040
	LW155	=.027
	M198	=.013
displace	=.040	
	AMS	=.040
	Whd155	=.040
	HIMARS	=.040
	M119	=.020
	LW155	=.020
	M198	=.013
6400mil	=.030	
	AMS	=.030
	HIMARS	=.030
	M119	=.015
	LW155	=.015
	M198	=.015
	Whd155	=.015
spades?	=.030	
	AMS	=.030
	HIMARS	=.030
	M119	=.000
	LW155	=.000
	M198	=.000
	Whd155	=.000
firepwr	=.200	
burst	=.040	
	AMS	=.040
	Whd155	=.040

MEU

HIMARS =.040

LW155 =.020

M119 =.000

M198 =.000

precise =.040

AMS =.040

LW155 =.040

M198 =.040

Whd155 =.040

HIMARS =.020

M119 =.000

direct? =.040

M119 =.040

AMS =.040

LW155 =.040

M198 =.040

Whd155 =.000

HIMARS =.000

range =.030

Whd155 =.030

HIMARS =.028

LW155 =.014

M198 =.014

M119 =.011

AMS =.008

lethal =.030

HIMARS =.030

LW155 =.004

M198 =.004

Whd155 =.003

AMS =.001

M119 <.001

rate =.020

Whd155 =.020

AMS =.013

M119 =.010

HIMARS =.010

LW155 =.008

B-5

MEU

	M198 =.007		
crew =.150			
	protect =.090		
	AMS =.090		
	HIMARS =.090		
	Whd155 =.045		
	M119 =.000		
	LW155 =.000		
	M198 =.000		
	size =.060		
	HIMARS =.060		
	AMS =.045		
	M119 =.036		
	Whd155 =.030		
	LW155 =.026		
	M198 =.016		
sustain =.150			
	ammo =.090		
	M119 =.090		
	AMS =.090		
	LW155 =.090		
	M198 =.090		
	Whd155 =.090		
	HIMARS =.090		
	equip =.030		
	M119 =.030		
	LW155 =.030		
	M198 =.030		
	HIMARS =.030		
	AMS =.020		
	Whd155 =.010		
	maint =.030		
	M119 =.030		
	LW155 =.030		
	M198 =.030		
	AMS =.015		
	Whd155 =.015		
	HIMARS =.015		

B-6

FORCED ENTRY

GOAL

GOAL

(1.000)

transpor

(0.300)

weight ▼

size ▼

crew

(0.150)

protect ▼

size ▼

agility

(0.150)

mobili ▼

emplace ▼

6400mil ▼

spades? ▼

displace ▼

firepwr

(0.300)

range ▼

rate ▼

burst ▼

lethal ▼

precise ▼

direct? ▼

sustain

(0.100)

ammo ▼

equip ▼

maint ▼

M119

AMS

LW155

M198

Whd155

HIMARS

Abbreviation

Definition

(Priorities shown are 'Local' - relative to parent node.)

FORCED ENTRY

Synthesis of Leaf Nodes with respect to GOAL

Ideal Mode

OVERALL INCONSISTENCY INDEX = 0.0

HIMARS	.204	
AMS	.196	
M119	.174	
Whd155	.169	
LW155	.142	
M198	.116	

Abbreviation	Definition
HIMARS	
AMS	
M119	
Whd155	
LW155	
M198	

FORCED ENTRY

Synthesis of Leaf Nodes with respect to GOAL

Ideal Mode

OVERALL INCONSISTENCY INDEX = 0.0

LEVEL 1	LEVEL 2	LEVEL 3	LEVEL 4	LEVEL 5
transpor=.300				
	weight =.150			
		wpnonly =.105		
			M119 =.105	
			LW155 =.048	
			M198 =.027	
			HIMARS =.014	
			AMS =.014	
			Whd155 =.011	
		w/truck =.045		
			M119 =.045	
			LW155 =.014	
			HIMARS =.013	
			AMS =.013	
			M198 =.011	
			Whd155 =.010	
	size =.150			
		w/truck =.120		
			AMS =.120	
			HIMARS =.118	
			M119 =.115	
			Whd155 =.079	
			LW155 =.056	
			M198 =.049	
		wpn only=.030		
			M119 =.030	
			LW155 =.017	
			AMS =.016	
			HIMARS =.016	
			M198 =.012	
			Whd155 =.010	
firepwr =.300				
	range =.060			

FORCED ENTRY

	Whd155 =.060	
	HIMARS =.056	
	LW155 =.027	
	M198 =.027	
	M119 =.022	
	AMS =.017	
rate =.060		
	Whd155 =.060	
	AMS =.040	
	M119 =.030	
	HIMARS =.030	
	LW155 =.025	
	M198 =.020	
lethal =.060		
	HIMARS =.060	
	LW155 =.008	
	M198 =.008	
	Whd155 =.006	
	AMS =.003	
	M119 =.002	
precise =.060		
	AMS =.060	
	LW155 =.060	
	M198 =.060	
	Whd155 =.060	
	HIMARS =.030	
	M119 =.000	
burst =.030		
	AMS =.030	
	Whd155 =.030	
	HIMARS =.030	
	LW155 =.015	
	M119 =.000	
	M198 =.000	
direct? =.030		
	M119 =.030	
	AMS =.030	
	LW155 =.030	

FORCED ENTRY

		M198 =.030	
		Whd155 =.000	
		HIMARS =.000	
crew =.150			
	size =.090		
		HIMARS =.090	
		AMS =.068	
		M119 =.054	
		Whd155 =.045	
		LW155 =.039	
		M198 =.025	
	protect =.060		
		AMS =.060	
		HIMARS =.060	
		Whd155 =.030	
		M119 =.000	
		LW155 =.000	
		M198 =.000	
agility =.150			
	mobili =.045		
		M119 =.045	
		AMS =.045	
		Whd155 =.045	
		HIMARS =.045	
		LW155 =.030	
		M198 =.015	
	emplace =.045		
		AMS =.045	
		Whd155 =.045	
		M119 =.022	
		LW155 =.018	
		HIMARS =.018	
		M198 =.013	
	displace=.030		
		AMS =.030	
		Whd155 =.030	
		HIMARS =.030	
		M119 =.015	

FORCED ENTRY

	LW155 =.015	
	M198 =.010	
6400mil =.015		
	AMS =.015	
	HIMARS =.015	
	M119 =.007	
	LW155 =.007	
	M198 =.007	
	Whd155 =.007	
spades? =.015		
	AMS =.015	
	HIMARS =.015	
	M119 =.000	
	LW155 =.000	
	M198 =.000	
	Whd155 =.000	
sustain =.100		
ammo =.060		
	M119 =.060	
	AMS =.060	
	LW155 =.060	
	M198 =.060	
	Whd155 =.060	
	HIMARS =.060	
equip =.020		
	M119 =.020	
	LW155 =.020	
	M198 =.020	
	HIMARS =.020	
	AMS =.013	
	Whd155 =.007	
maint =.020		
	M119 =.020	
	LW155 =.020	
	M198 =.020	
	AMS =.010	
	Whd155 =.010	
	HIMARS =.010	

MTW

GOAL

GOAL
(1.000)

transpor (0.167)	crew (0.167)	agility (0.167)	firepwr (0.375)	sustain (0.125)
weight ▼	protect ▼	mobili ▼	range ▼	ammo ▼
size ▼	size ▼	emplace ▼	rate ▼	equip ▼
		6400mil ▼	burst ▼	maint ▼
		spades? ▼	lethal ▼	
		displace ▼	precise ▼	
			direct? ▼	

M119

AMS

LW155

M198

Whd155

HIMARS

Abbreviation

Definition

(Priorities shown are Local - relative to parent node)

Synthesis of Leaf Nodes with respect to GOAL

Ideal Mode

OVERALL INCONSISTENCY INDEX = 0.0

HIMARS	.221	
AMS	.198	
Whd155	.183	
M119	.144	
LW155	.136	
M198	.118	

Abbreviation	Definition
HIMARS	
AMS	
Whd155	
M119	
LW155	
M198	

M T W

Synthesis of Leaf Nodes with respect to GOAL

Ideal Mode

OVERALL INCONSISTENCY INDEX = 0.0

LEVEL 1	LEVEL 2	LEVEL 3	LEVEL 4	LEVEL 5
firepwr =.375				
	range =.094			
		Whd155 =.094		
		HIMARS =.088		
		LW155 =.043		
		M198 =.043		
		M119 =.034		
		AMS =.026		
	lethal =.094			
		HIMARS =.094		
		LW155 =.013		
		M198 =.013		
		Whd155 =.010		
		AMS =.004		
		M119 =.003		
	rate =.075			
		Whd155 =.075		
		AMS =.050		
		M119 =.038		
		HIMARS =.038		
		LW155 =.031		
		M198 =.025		
	precise =.075			
		AMS =.075		
		LW155 =.075		
		M198 =.075		
		Whd155 =.075		
		HIMARS =.038		
		M119 =.000		
	burst =.019			
		AMS =.019		
		Whd155 =.019		
		HIMARS =.019		

MTW

		LW155 =.009		
		M119 =.000		
		M198 =.000		
	direct? =.019			
		M119 =.019		
		AMS =.019		
		LW155 =.019		
		M198 =.019		
		Whd155 =.000		
		HIMARS =.000		
transpor=.167				
	size =.133			
		w/truck =.120		
			AMS =.120	
			HIMARS =.118	
			M119 =.115	
			Whd155 =.079	
			LW155 =.056	
			M198 =.049	
		wpn only=.013		
			M119 =.013	
			LW155 =.007	
			AMS =.007	
			HIMARS =.007	
			M198 =.006	
			Whd155 =.005	
	weight =.033			
		w/truck =.030		
			M119 =.030	
			LW155 =.009	
			HIMARS =.009	
			AMS =.009	
			M198 =.007	
			Whd155 =.007	
		wpnonly =.003		
			M119 =.003	
			LW155 =.002	
			M198 <.001	

M T W

	HIMARS <.001	
	AMS <.001	
	Whd155 <.001	
crew =.167		
size =.100		
	HIMARS =.100	
	AMS =.075	
	M119 =.060	
	Whd155 =.050	
	LW155 =.043	
	M198 =.027	
protect =.067		
	AMS =.067	
	HIMARS =.067	
	Whd155 =.033	
	M119 =.000	
	LW155 =.000	
	M198 =.000	
agility =.167		
mobili =.050		
	M119 =.050	
	AMS =.050	
	Whd155 =.050	
	HIMARS =.050	
	LW155 =.033	
	M198 =.017	
emplace =.050		
	AMS =.050	
	Whd155 =.050	
	M119 =.025	
	LW155 =.020	
	HIMARS =.020	
	M198 =.014	
displace=.033		
	AMS =.033	
	Whd155 =.033	
	HIMARS =.033	
	M119 =.017	

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MTW

	LW155	=.017
	M198	=.011
6400mil		=.017
	AMS	=.017
	HIMARS	=.017
	M119	=.008
	LW155	=.008
	M198	=.008
	Whd155	=.008
spades?		=.017
	AMS	=.017
	HIMARS	=.017
	M119	=.000
	LW155	=.000
	M198	=.000
	Whd155	=.000
sustain		=.125
ammo		=.075
	M119	=.075
	AMS	=.075
	LW155	=.075
	M198	=.075
	Whd155	=.075
	HIMARS	=.075
equip		=.025
	M119	=.025
	LW155	=.025
	M198	=.025
	HIMARS	=.025
	AMS	=.017
	Whd155	=.008
maint		=.025
	M119	=.025
	LW155	=.025
	M198	=.025
	AMS	=.013
	Whd155	=.013
	HIMARS	=.013